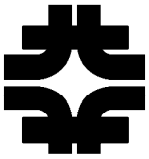

Fermi National Accelerator Laboratory

CDF Run IIb

CABLES AND CONNECTORS BETWEEN COT AND JPC (LAYER 1 OR HIGHER)

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-PRELIMINARY-

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1 Introduction

This document describes the cables used to connect the Junction Port Card (JPC), the Junction Card (JC) and the Mini-Port Card (see Figure 1). The JC is a complete passive card used for detector assembly purposes. The distances between the JPC and JC is ~4m and between the JC and MPC ~1m. For this interconnection each MPC requires three types of cables: signal cables, power cables and high voltage cables. Figure 1 shows just the signal cable, it does not show the power and high voltage supplies and associated cables. One JPC connects to five MPC. Therefore, the JPC interconnects to five sets of these three types of cables.

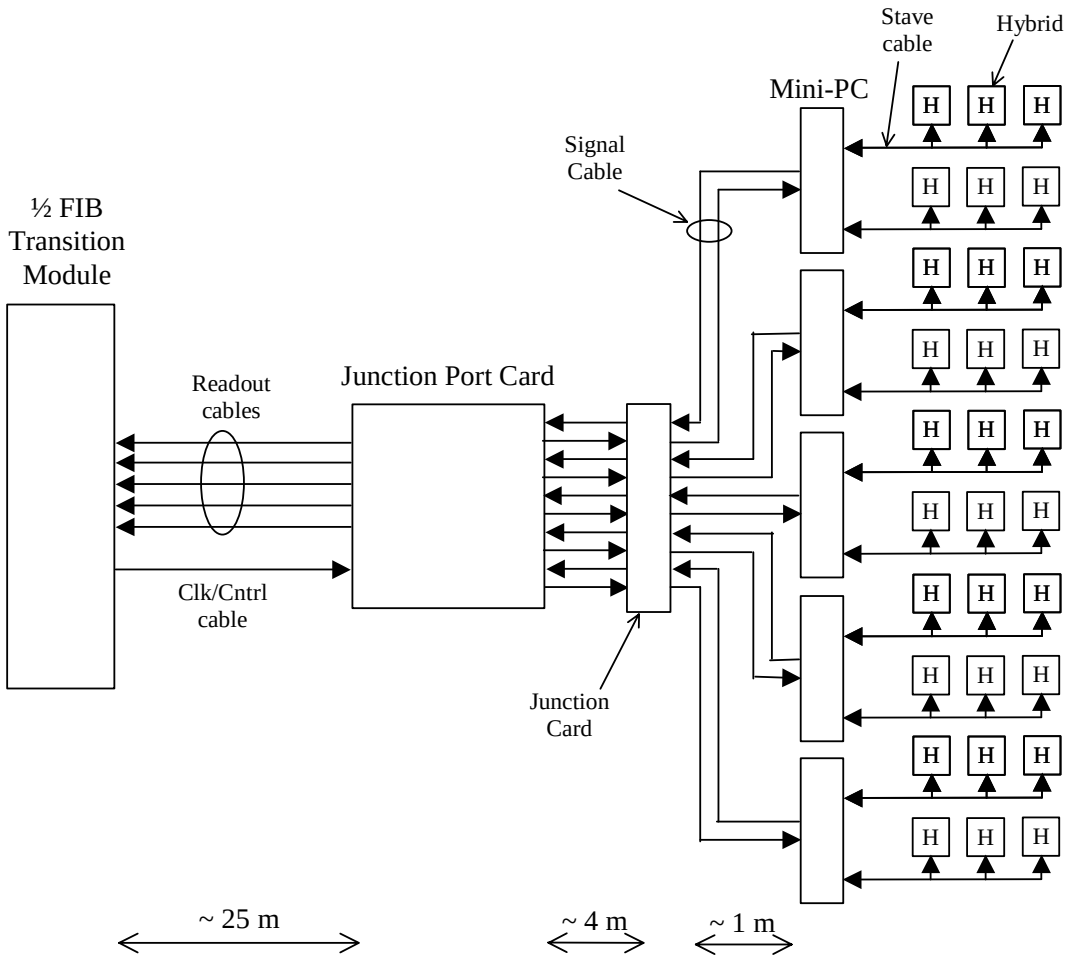


Figure 1. MPC Interconnected With Other Devices

All the communication between the JPC and MPC is done differentially through the signal cable. The MPC is mounted at the end of the stave and electrically connected to the stave buses. Figure 2 shows a drawing of stave assembly with the MPC and the hybrids. These three types of cables are not connected directly to the MPC. They are connected to a pair of flex pigtails (described elsewhere) which strain relieves any pressure over the MPC.

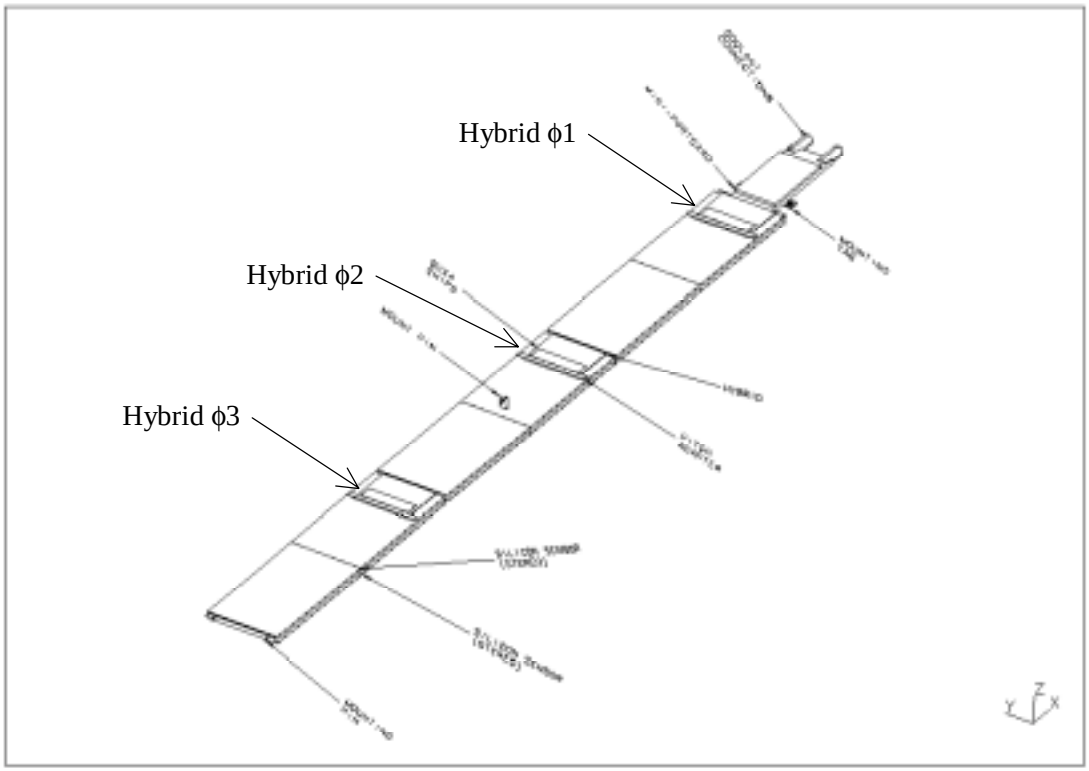


Figure 2. Stave Assembly

In the span separating the JPC and the JC the cables have to pass through a small slot in the Central Outer Tracker (COT). These slots constraint the size of the cables. Also, the cables have to be low mass to reduce the overall mass of the detector. Figure 3 shows a cross section of the COT slot and possible dimensions of the cables. Observe in this figure that it has enough space to accommodate all the cables between one JPC and five MPC.

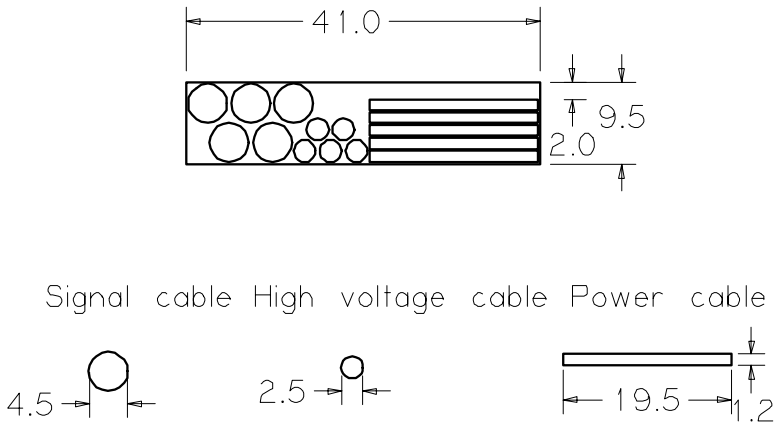


Figure 3. COT Slot and Cables

These cables have to support considerable radiation. Appendix A describes the radiation tolerance of different insulators [1]. From this table one can see that Teflon PTFE does not support enough radiation while Tefzel does.

2 Estimated Currents

There is resistive voltage drop in the power cables. Table 1 shows the expected currents for the SVX4 chip, the hybrids and stave cable (each stave cable connects to three hybrids). The estimated current of the MPC is similar to the hybrid.

Table 1. Estimated SVX4 Currents (in Amperes)

	SVX4	Hybrid	Stave Cable
A_{IDD}	0.1	0.4	1.2
$D_{IDD(quiescent)}$	0.1	0.4	1.2
$D_{IDD(readout)}$	0.2	0.5	1.3

3 Signal Cable and Connector

This is a custom design cable. The signal cable is composed of 24 twisted pairs (23 pairs presently assigned, one spare) of 34 AWG wire (see Figure 4 and Table 2). The total maximum diameter of the cable has to be smaller than 4.5 mm. The cable should be shielded (as, for example, with an Aluminum foil), and should have a drain wire electrically connected to the shielding. A preferable characteristic is color-coded wires.

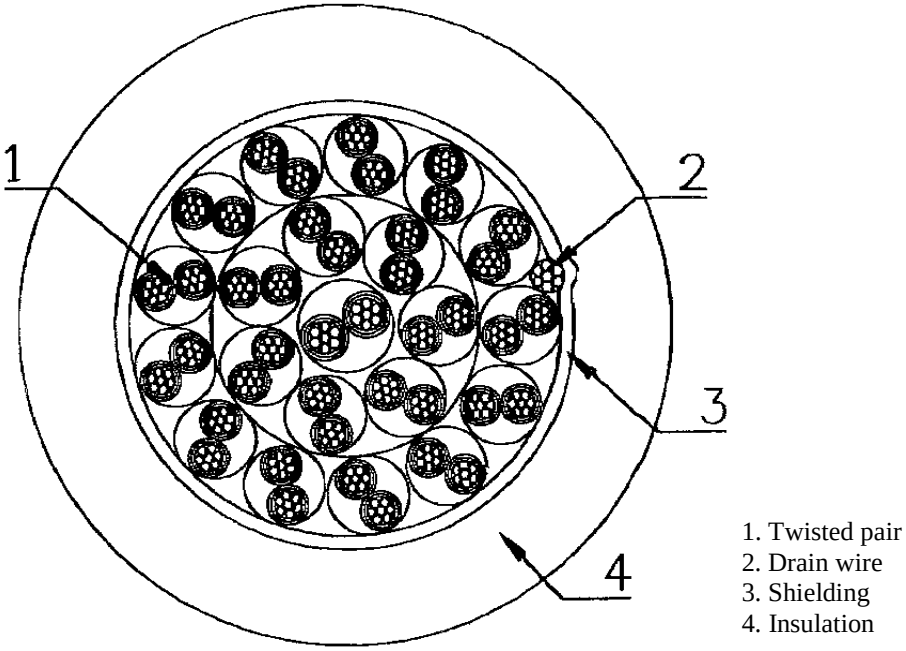


Figure 4. Sketch of the Signal Cable

Table 2. Signal Cable Characteristics

Number of twisted pairs	24
Wire conductor	34 AWG, strand
Total radiation dose	5 Mrad
Maximum overall diameter	< 4.5 mm
Voltage rating	50 V
Temperature rating	-10 to 100°C
Drain wire	34 AWG, strand, laid parallel under shield
Shielding thickness	> 200 μm
Length (total)	3000 to 4000 feet

We intend to terminate this cable with the Omnetics 0.025" centerline Nano series connector (www.omnetics.com). The pins and sockets of this connector accept 34 AWG wire. Presently the maximum number of sockets in the dual row connector is 44. Therefore, we will use two connectors, one with 24 sockets (for 12 pairs) and another with 26 sockets (for 12 pairs and drain wire). Figure 5 shows a sketch of the terminated cable.

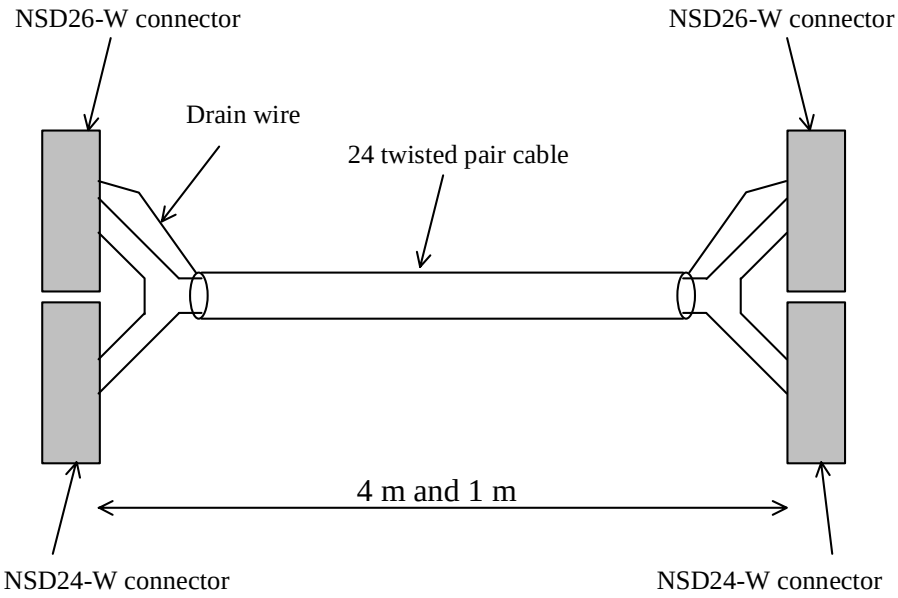


Figure 5. Signal Cable Assembly

Figure 6 shows a drawing of the connector. The cable connector types are:

a) NSD24-W: Nano connector, socket, dual row, 24 contacts, for insulated lead wire
b) NSD26-W: Nano connector, socket, dual row, 26 contacts, for insulated lead wire

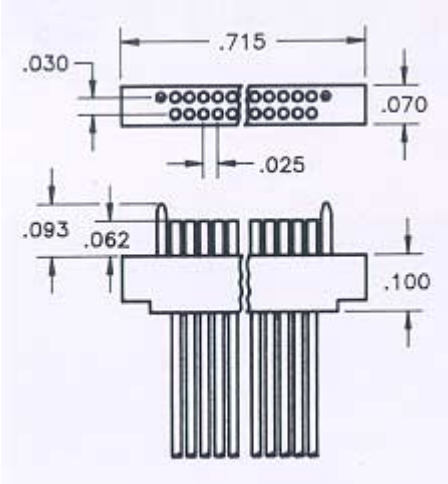


Figure 6. Drawing of the NSDx-W Nano Socket Connector

Figure 7 shows the drawing of the connector that will be assembled in the flex pigtail side REQUIRES CONFIRMATION FROM OMNETICS:

a) NPD24-TH4: Nano connector, pin, dual row, 24 contacts, thru hole leads, 4 rows
b) NPD26-TH4: Nano connector, pin, dual row, 26 contacts, thru hole leads, 4 rows

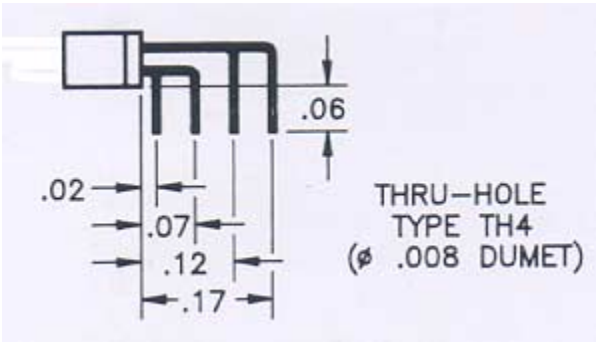


Figure 7. Drawing of the NPDx-TH4 Nano Pin Connector

4 Power Cable and Connector

Table 1 estimates the current requirements. We will assume that the readout current is the same as quiescent. The expected distance between the MPC and JPC is ~5 m (WE NEED DO CHECK), and therefore, the sum of the power and ground wire length is 10 m. Table 3 shows the estimated voltage drop on the power cable when feeding different numbers of hybrids. We will assume that a voltage drop smaller than 650 mV is acceptable.

Table 3. Voltage Drop on Power Cables

AWG	R(mΩ/m)	R_{Total}(mΩ)	ΔV (mV) (1 hybrid)	ΔV (mV) (2 hybrid)	ΔV (mV) (3 hybrid)
22	54	540	216	430	650
24	84	840	336	670	1.0 V
26	140	1400	560	1.1 V	1.7 V
28	230	2300	920	1.8 V	2.8 V

Table 4 shows the characteristics of the power cable and Table 5 shows the use of the wires in the power cable. With this proposed use the maximum voltage drop is in the analog power and ground cables (~650 mV).

Table 4. Power Cable Characteristics

Manufacturer	Amphenol
Part number	843-111-2214-015
Type	Ribbon cable, Spectra-Bond parallel conductors
Number of conductors	15
Wire conductor	22 AWG, strand
Length (total)	3000 to 4000 feet

Table 5. Power Cable Wire Utilization

Wire Allocation	# of Wires	Description
DVDD_MPC	1	DVDD Mini-Port Card
DVDD_Hybrid1ϕ	1	DVDD for hybrid 1, ϕ side
DVDD_Hybrid2ϕ	1	DVDD for hybrid 2, ϕ side
DVDD_Hybrid3ϕ	1	DVDD for hybrid 3, ϕ side
DVDD_Hybrid1*z*	1	DVDD for hybrid 1, *z* side
DVDD_Hybrid2*z*	1	DVDD for hybrid 2, *z* side
DVDD_Hybrid3*z*	1	DVDD for hybrid 3, *z* side
DGND	4	Digital Ground
AVDD_ϕ	1	AVDD, all hybrids, ϕ side
AGND_ϕ	1	AGND, all hybrids, ϕ side
AVDD_*z*	1	AVDD, all hybrids, ϕ side
AGND_*z*	1	AGND, all hybrids, ϕ side
Total	15	

We intend to connect this cable to a Hirose connector DF11 series (www.hirose.com). The pins and sockets for 22 AWG wire is rated for 2A. Two of the connector variations are shown in Figure 8 and Figure 9. Figure 8 shows the right angle pin header portion of this connector (presently considered for the MPC flex pigtail side) and Figure 9 shows the proposed socket.

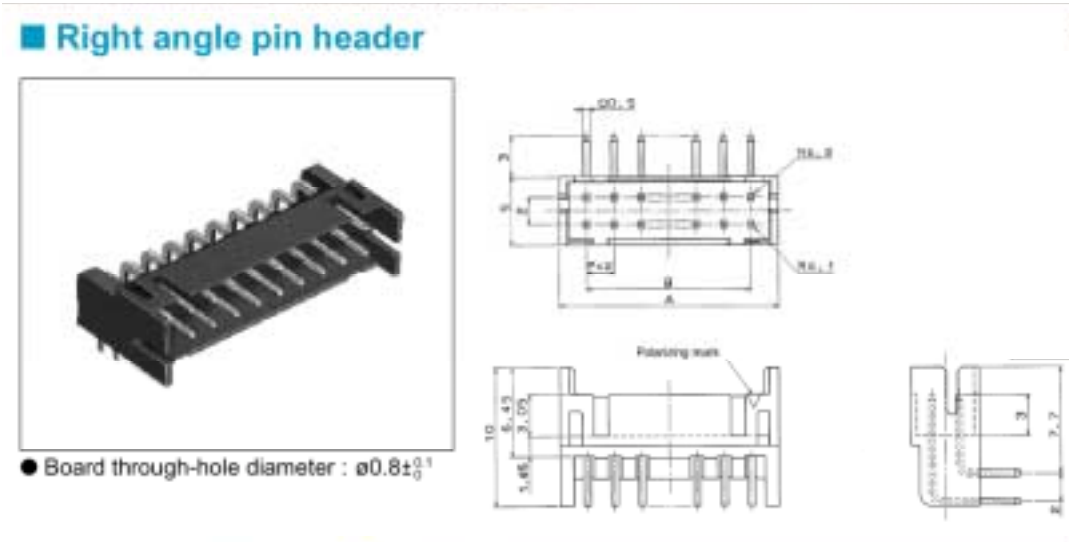


Figure 8. Hirose Right Angle Connector

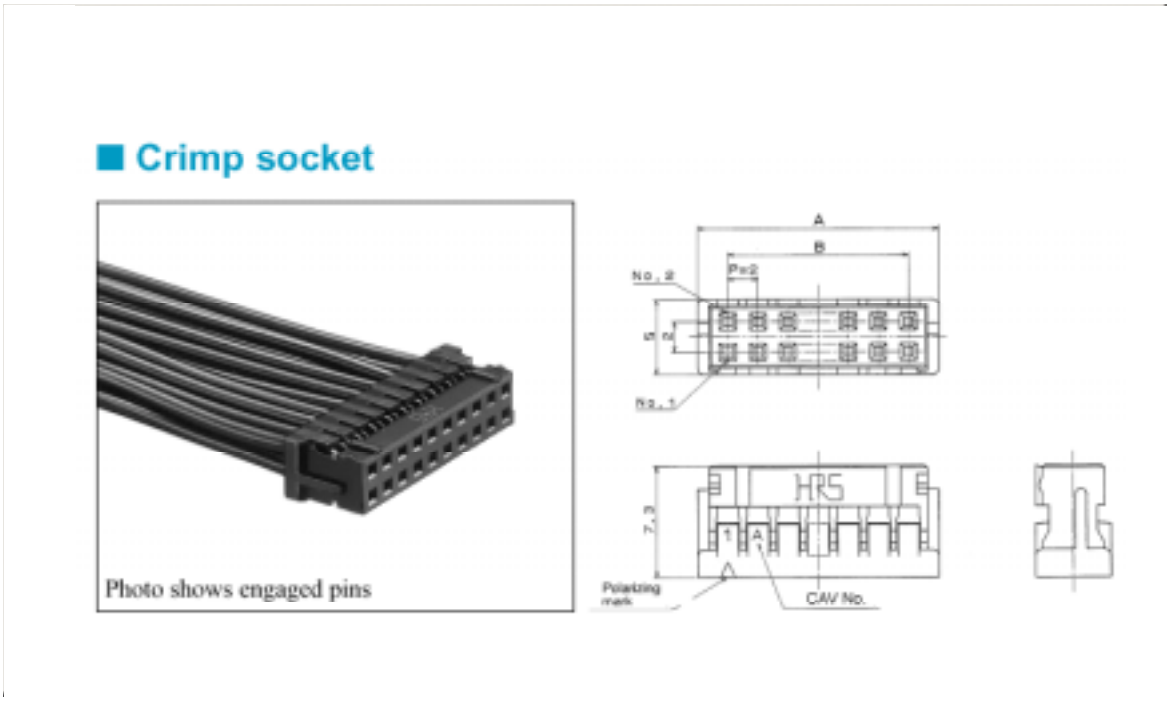


Figure 9. Hirose Socket

Figure 10 shows the connector assembly with these two variations. Figure 11 shows a proposed extension plug for the JC. This plug is mounted directly in a cutout (also shown in the picture) in the JC and the corresponding crimp socket (as in Figure 9) inserts directly into the plug. With such arrangement we save connections.

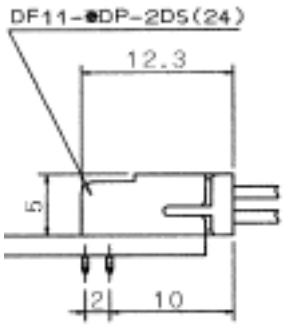


Figure 10. Connector Assembly

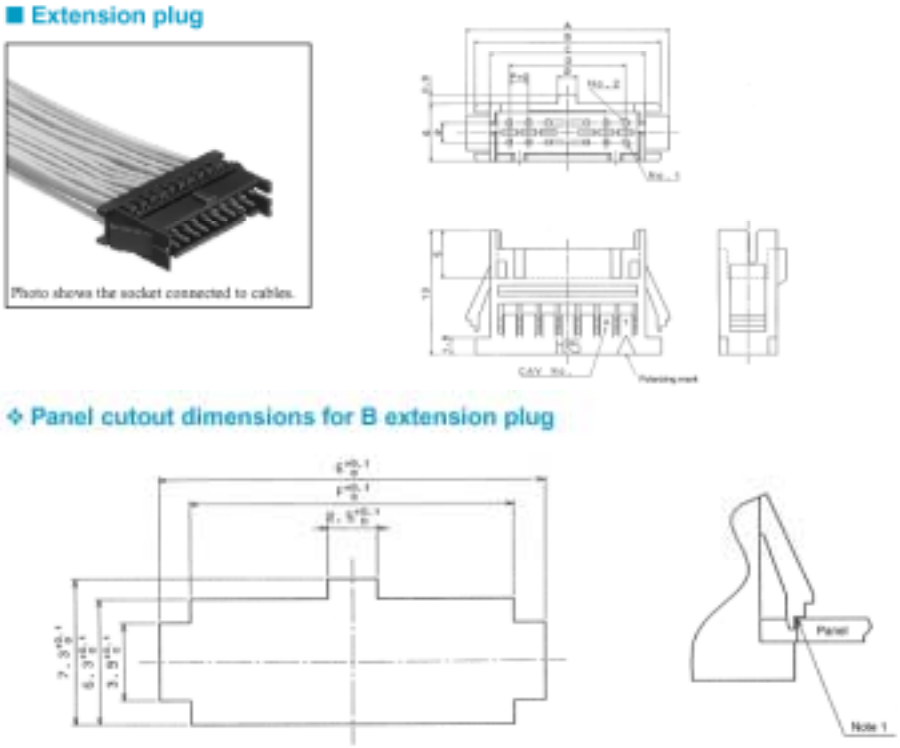


Figure 11. Proposed Extension Plug for Junction Card

5 High Voltage Cable and Connector

This is also a custom design cable. This cable is similar to the signal cable with the following differences: 6 twisted pairs, higher voltage and smaller overall diameter (see Table 6).

Table 6. High Voltage Cable Characteristics

Number of twisted pairs	6
Wire conductor	34 AWG, strand
Total radiation dose	5 Mrad
Maximum overall diameter	< 3.0 mm
Voltage rating	500 V
Temperature rating	-10 to 100°C
Drain wire	34 AWG, strand, laid parallel under shield
Shielding thickness	> 200 μm
Length (total)	3000-4000 feet

The minimum distance between traces in rigid and flex boards is given by the IPC-248 and 2221 specs. They require a minimum of 2.5 mm (100 mils) for external conductors, uncoated, sea level to 3050m high.

We intend to terminate this cable with the same Omnetics 0.025" centerline Nano series connector as proposed for the signal cable. However, to account for the minimum distance between conductors, we will order the connectors such that we skip four sockets and pins between the high voltage pins and high voltage and ground. The ground pins can be assembled side by side. Figure 12 shows a sketch of such connector. Observe that the pitch of the HV pins is more than the required 2.5 mm to account for the pad cover size on the circuit board.

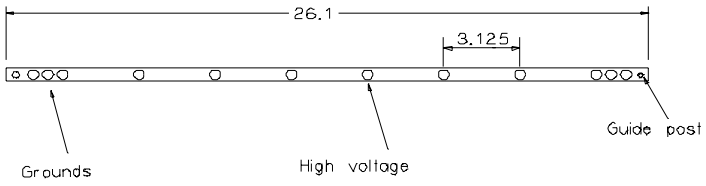
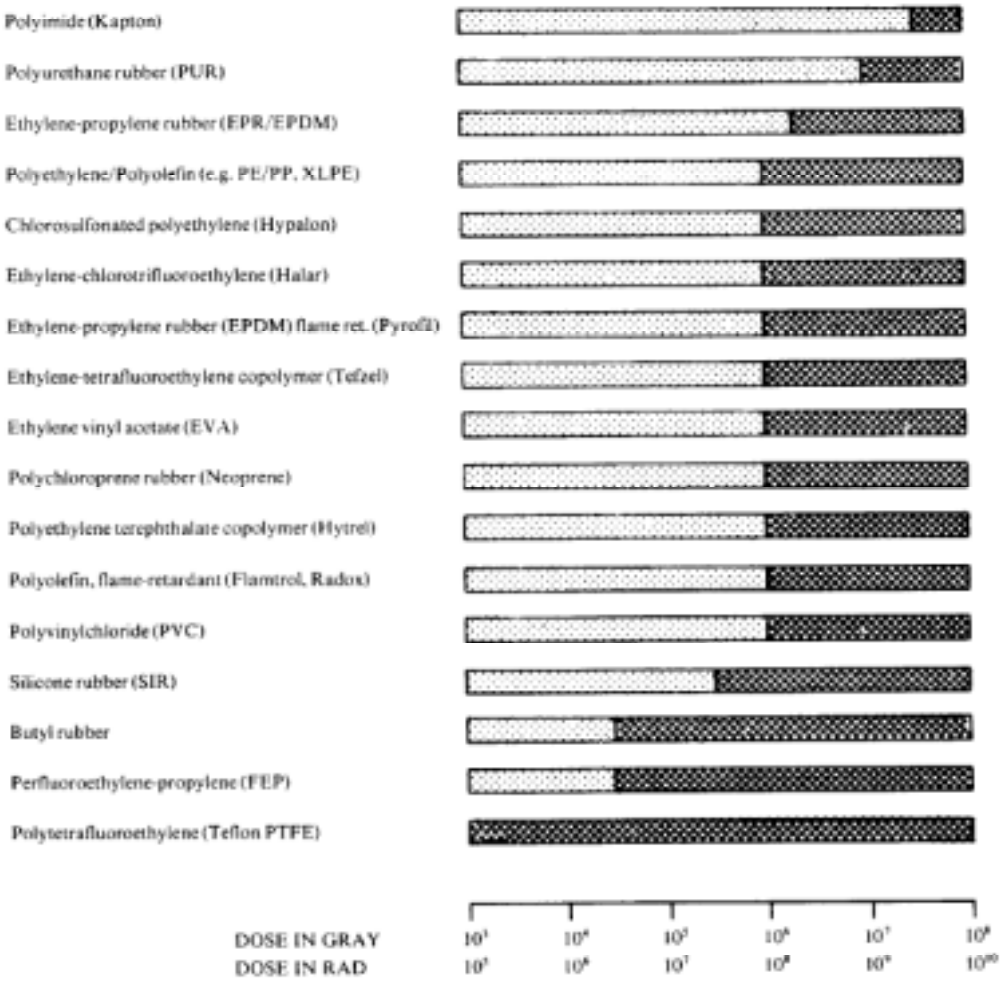


Figure 12. Sketch of the Omnetics Connector Adapted for H.V.

6 Appendix: Classification of Material According to their Radiation Resistance

These data can only serve as a general guideline. Atmospheric and other environmental conditions such as temperature and dose rate are not taken into consideration [1].



7 Reference

[1] CERN document report 82-10